2.0 ALTERNATIVES

2.1 INTRODUCTION

The Joint-Lead Agencies have considered several techniques for improving aquatic habitats at an intermediate scale (mesohabitats) for the RGSM within the Middle Rio Grande (MRG). The MRG is defined as the Rio Grande and its tributaries from the New Mexico-Colorado state line downstream to the inflow of Elephant Butte Reservoir, equaling the elevation at Elephant Butte Dam spillway crest (4,450 feet above mean sea level). The aquatic habitat restoration techniques discussed in the Habitat Restoration Plan for the Middle Rio Grande (Tetra Tech 2004) were developed specifically for compliance with the 2003 MRG BO and were used as the preliminary set of techniques that are proposed to be implemented and evaluated in this EA, as summarized in Tables 2.1 and 2.2. The objective of these activities varies, with most serving to improve multiple processes and functions of the riverine and riparian system. All techniques can potentially be used to improve RGSM habitat (Tetra Tech 2004). Each of the restoration techniques considered incorporates both passive and active restoration elements, an approach which works with the river instead of against it. The adoption of passive restoration techniques provides the best opportunity for long-term success and should be considered whenever possible (Tetra Tech 2004). Several subreach alternatives were initially considered including the Pueblo of Sandia, the North Diversion Channel, the Interstate 40 (I-40)/Central Avenue, and the South Diversion Channel river segments.

2.2 ALTERNATIVES CONSIDERED

Two alternatives, the No Action and one Action alternative are analyzed in detail in this environmental assessment.

The Action Alternative includes the following habitat restoration techniques: terrace and bank lowering, creation of high-flow ephemeral channels, high-flow bank-line embayments, main-channel widening, removal of lateral confinements, river bar and island enhancement, modification of islands and bars, and addition of woody debris (Tetra Tech 2004) (Table 2.1). However, in the evaluation process the selected techniques have been developed further and, in some cases, have been combined with other selected techniques. All techniques will utilize the benefits of passive restoration. Detailed descriptions are provided in Sections 2.5.1 and 2.5.2. Bank lowering and large woody debris techniques remain as described. The high-flow ephemeral channel technique is designated herein as ephemeral channel construction and would be constructed only within mid-channel islands or attached bars. High-flow bank-like embayments are referred to as bank scouring. Main-channel widening and removal of lateral confinements will be achieved as part of scouring and bank lowering activities. River bar and island enhancement will effectively be combined with the modification of islands and bars. Vegetated island modification and evaluation is one proposed technique, and bar habitat modification is presented as a separate technique. Subreaches selected for implementation are the North Diversion Channel, I-40/Central, and the South Diversion Channel.

Table 2.1. Proposed Habitat Restoration Techniques

Technique	Description	Benefits of Technique
Passive restoration	Allows for higher-magnitude peak flows to accelerate natural channel-forming process and improve floodplain habitat.	Increases sinuosity and allows for development of complex and diverse habitat, including bars, islands, side channels, sloughs, and braided channels.
Terrace and bank lowering	Removal of vegetation and excavation of soils adjacent to the main channel to create potential for overbank flooding.	Could provide for increased retention of RGSM eggs and larvae.
High-flow ephemeral channels	Construction of ephemeral channels on islands to carry flow from the main river channel during high-flow events.	Normally dry but creates shallow, ephemeral, low-velocity aquatic habitats important for RGSM egg and larval development during high flow time periods.
High-flow bank-line embayments	Areas cut into banks where water enters, primarily during high-flow events including spring runoff and floods.	Intended to retain drifting RGSM eggs and to provide rearing habitat and enhance food supplies for developing RGSM larvae.
Main channel widening	Excavation of banks and lateral expansion of active channel.	Intended to reduce average flow velocities and increase total area of lower-velocity, shallow habitat for young-of-year and adult RGSM.
Removal of lateral confinements	Reduction or elimination of structural features and maintenance practices that decrease bank erosion potential.	Creates wider floodplain with more diverse channel and floodplain features, resulting in increased net-zero and low-velocity habitat for RGSM.
River bar and island enhancement	Elimination of channel maintenance and provisions to encourage island and bar formation.	Improves aquatic habitat heterogeneity by creating backwaters, eddy zones, and shear zones to increase habitat for all life stages of RGSM.
Modification of islands and bars	Involves the physical disturbance (discing, mowing, root-plowing, raking) of islands or bars to remove vegetation and mobilize the features during high flows.	Creates more complex habitat for RGSM by reducing average channel depth, widening the channel, and increasing backwaters, pools, eddies, and runs of various depths and velocities.
Woody debris	Placement of trees, root wads, stumps, or branches in the main river channel or along its banks.	Creates slow-water habitats for all life stages of RGSM, provides shelter from predators and winter habitat, and provides structure for periphyton growth to improve food availability for RGSM.

Table 2.2. Techniques Eliminated from Further Study

Technique	Description	Benefits of Technique
Arroyo connectivity	Clearing of vegetation and/or excavation of pilot channels to bring stranded arroyos to grade with the mainstem Rio Grande.	Could re-establish eddies associated with the mouths of arroyos, which may help to retain RGSM eggs and larvae, and increases the supply of sediment to the river.
Gradient-control structures	Low head weirs constructed perpendicular to the channel with aprons to simulate natural riffles.	Creates aquatic habitat diversity by producing variable flow velocities and depths.
Sediment management	Increased sediment supply through mobilization behind dams, arroyo reconnection, or introduction of spoils.	Supports the observation that RGSM is most commonly found in areas where the bed is predominantly silt and sand.
Fish passage	Installation of fish passage structures at impoundments to improve longitudinal connectivity of river.	Allows upstream movement of RGSM and reduces habitat fragmentation.

2.3 OTHER ALTERNATIVES CONSIDERED BUT ELIMINATED

An alternative consisting of arroyo connectivity, gradient-control structures, sediment management, and fish passage was eliminated from consideration during the evaluation process (Table 2.2). Although these techniques may have positive habitat implications, they have been eliminated for the three sites of this project due to cost, construction of structures in the channel, and increased sedimentation to the river.

2.4 NO ACTION ALTERNATIVE

The No Action Alternative assumes that no anthropogenic changes would occur to islands, bars, and shoreline environments and the riverine habitats available to the RGSM in the Albuquerque Reach at the proposed project locations. Current river operations, and trends in riverine habitat quality and quantity will remain dominant under the No Action Alternative.

2.5 PREFERRED ALTERNATIVE

The Preferred Alternative consists of the implementation of six restoration techniques, incorporating active and passive methods, to be applied initially at numerous sites within three subreaches between River Mile 194 (near the Alameda Bridge) and River Mile 176 on the southern end (0.5 mile south of the South Diversion Channel). Photographs of the three selected subreaches are in Appendix B. Figures 2.1–2.13 show the detailed locations of the Project elements within each subreach. The initial number of acres treated over the early phase of the project would be 70 acres, with the potential for 180-360 treated acres over the duration of the project.

The Rio Grande is a dynamic system, constantly changing both spatially and temporally. An integrative and passive approach would allow, to the extent possible, the development of natural river and floodplain features, including temporary bars and islands, ephemeral secondary channels, and lateral migration of the river across modified bars and islands. The application of each of the specific modification techniques will be used within the dynamic floodplain or channel to work synergistically with these natural hydrological processes. The initial modifications would create conditions under which the Rio Grande could shape the features within the river. The ultimate outcome would be greater mesohabitat diversity with a variety of flow velocity habitats.

The use of multiple techniques implemented in several locations also provides an economy of implementation and comparative monitoring of the effectiveness of each technique, alone and in combination with the others. Therefore, all components described below will be used to meet the overall purpose, objectives, and need of the project. Table 1.1 summarizes the action sites and their proposed locations. Three instream feature modification techniques and three bank modification techniques are included in the Preferred Alternative, as discussed in detail in Sections 2.5.1 and 2.5.2.

2.5.1 INSTREAM FEATURE MODIFICATION

Islands and bars are common features in braided river systems with significant supplies of sediment such as the Middle Rio Grande. Vegetated islands and bars contract and expand in response to flow and sediment changes within the river. The vegetated islands within the MRG have historically been transient, temporary features. They were commonly displaced or moved during high seasonal flows or were removed naturally during low flow periods or physically by Reclamation and other entities to maintain the river channel capacity. Bars are transient, unvegetated features of the river that may form into vegetated islands or become part of the riverbank over time. Under current river and climate conditions, where high sustained seasonal flows have been absent for the most part, many more of the islands have become vegetated features that restrict channel width and river migration through subreaches of the Albuquerque Reach.

Technique 1: Vegetated Island Modification and Evaluation
The Rio Grande naturally forms islands in some reaches and subreaches. The size, shape, amount of vegetation, and in-channel location of islands are related to flow conditions and sediment loads. Today, islands have become much more of a feature of the river. The amount of established vegetation increases the likelihood that islands would become permanent, as they become more difficult to move once vegetation is established and mature (Fluder 2004). These vegetated islands also serve as exposed substrate for the diffusion of invasive deciduous species.

Island modification, particularly on islands that may become permanent, may assist in alleviating adverse changes to RGSM critical habitat and improving the quality and quantity of available habitat (USFWS 2003). Islands can be modified by planned physical disturbance. Existing techniques for removing vegetation and destabilizing soil and sediment include mowing vegetation, root-plowing vegetation and sediment, and raking vegetation and surface sediment (Tetra Tech 2004). Under the Proposed Action, a number of techniques would be evaluated for their utility in addressing narrowing of the river channel and island attachment within the channel.

Islands would be selected for evaluating different methods of restoring them to a condition in which they would be seasonally inundated at moderate to high seasonal flows, similar to what occurs during overbank flooding on the floodplain. The islands may expand or contract in response to flows and sediment load and would be allowed to redeposit sediment in downstream subreaches of the Rio Grande.

The selected treatment would be applied to four to six islands; another island in each selected subreach would serve as a control point. The conceptual design for vegetated island modification and evaluation (Figure 2.1 and Figure 2.2) would take into account potential increased sediment retention in the modified sections of the river, as well as potential flow-through velocities and depths. Fringe vegetation would be left at the head of some of the islands to reduce flow velocities for selected islands. Methods for reducing the time and cost necessary to complete evaluation of each restoration site, as well as potential reconstruction or modification of the island, would be considered.

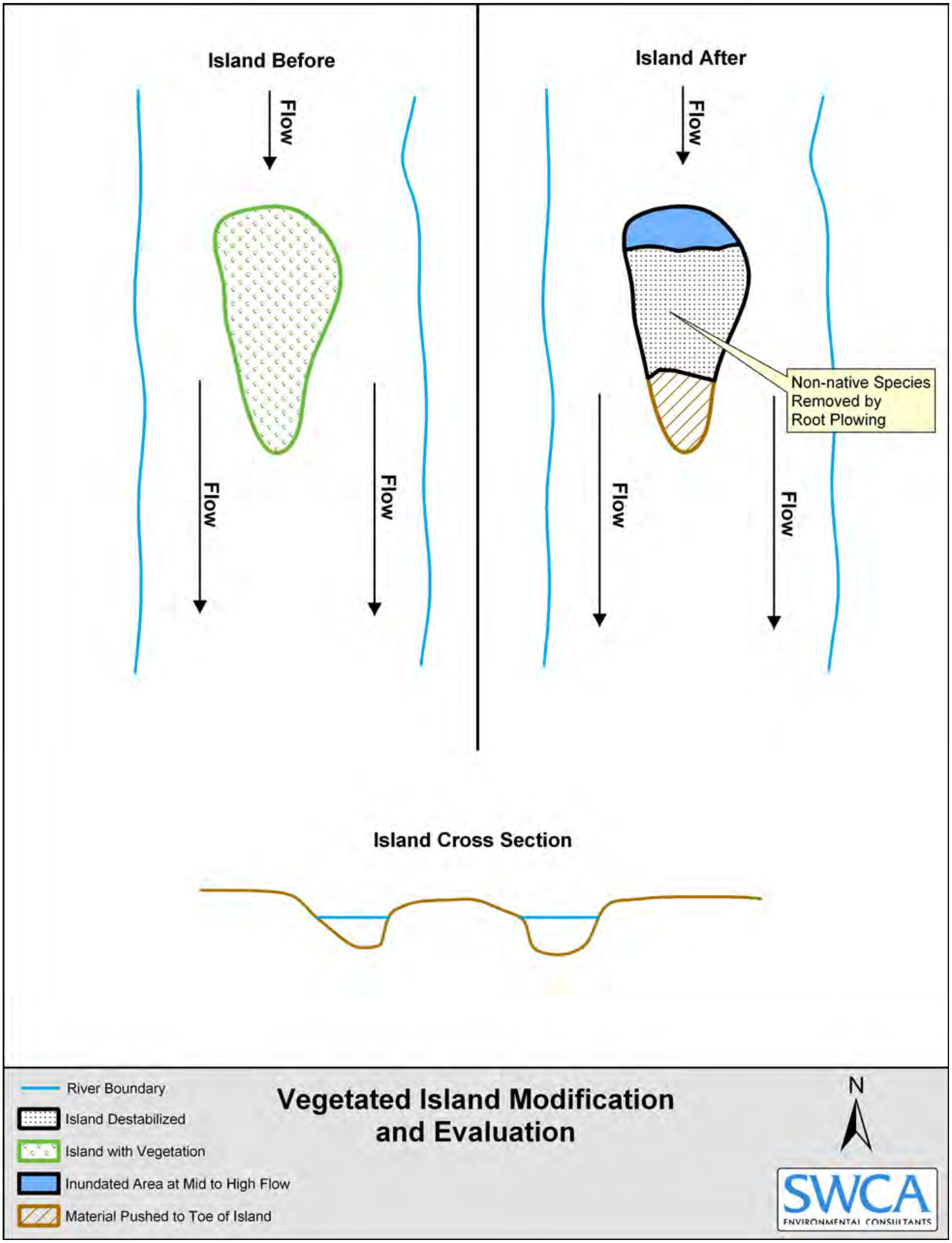

Figure 2.1. Schematic of the vegetated island modification and evaluation technique.

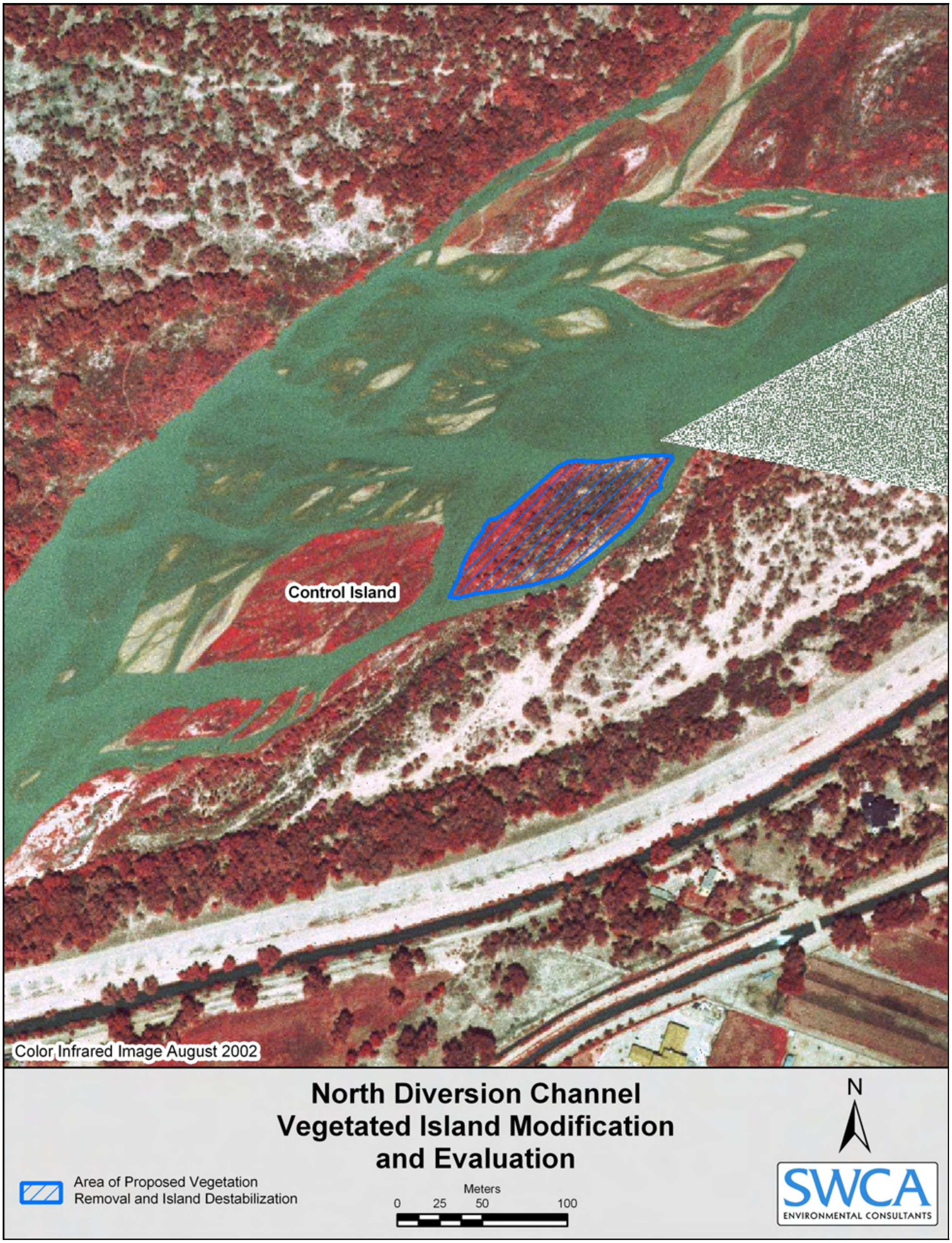

Figure 2.2. Example of the vegetated island modification and evaluation technique.

The treatment to be applied would be cutting non-native vegetation on these islands and plowing the roots to a depth suitable to eradicate invasive species. No other modifications would be made. The river would then be allowed to naturally shape the island during high flow events. After reshaping, the remaining island area may be replanted with selected appropriate native species to stabilize the island contours to the extent possible. Following restoration, the island would be expected to have a surface elevation suitable for inundation at moderate and high river flows.

Technique 2: Bar Habitat Modification

Bar habitat modification is similar to island habitat modification. Bars are transient, generally unvegetated features that typically form after a flood and are later removed during high flow events. Bars may be attached to the riverbank or isolated within the river's flow. Periods of sustained low flow increase the stability of river bars, with the potential for vegetation to become established. River maintenance efforts up until the mid-1980's focused on eliminating bars from the channel to maintain a consistent floodway for water delivery and reduce flood threat.

However, river bars increase the variety of available aquatic habitat by creating backwaters, eddy zones, and complex channel configuration (Tetra Tech 2004). The presence of these features and mesohabitats may provide habitat for the RGSM by providing interaction between the river and attached bars at high flows, emulating the floodplain functions within the range of river operations.

In their current configuration, most bars in the Albuquerque Reach of the MRG do not appear to have the correct surface topography to function as RGSM nursery habitat at low flows. However, the surfaces of these in-channel features could be modified to provide important nursery habitat identified by previous studies (Porter and Massong 2004). Techniques to be applied include: (1) lowering surfaces along the active river's edge to simulate connected shelf areas; (2) creating shelf areas within the point bar connected to the river via side channels; (3) constructing inlets connected to the river, either directly or via a side channel; and (4) constructing inlets that are connected to the river but also convey surface water runoff to the Rio Grande (Figures 2.3 and 2.4). The key process for the constructed areas is periodic flow of water through the entire inlet that would wash away fine sediments that have accumulated over time.

Technique 3: Ephemeral Channels on Bars and Islands

Ephemeral channels are low-velocity, flow-through channels that are connected to the main river channel across the bars and islands. These channels are normally dry but carry high-discharge flow from the main channel, characteristically during spring snowmelt and summer monsoon events. The channels carry water at lower velocities than the main channel and may include mesohabitats such as pools and backwaters with little or no flow. These ephemeral channels create aquatic habitat that would be beneficial to RGSM. Ephemeral channels are not intended to provide for overbank flooding.

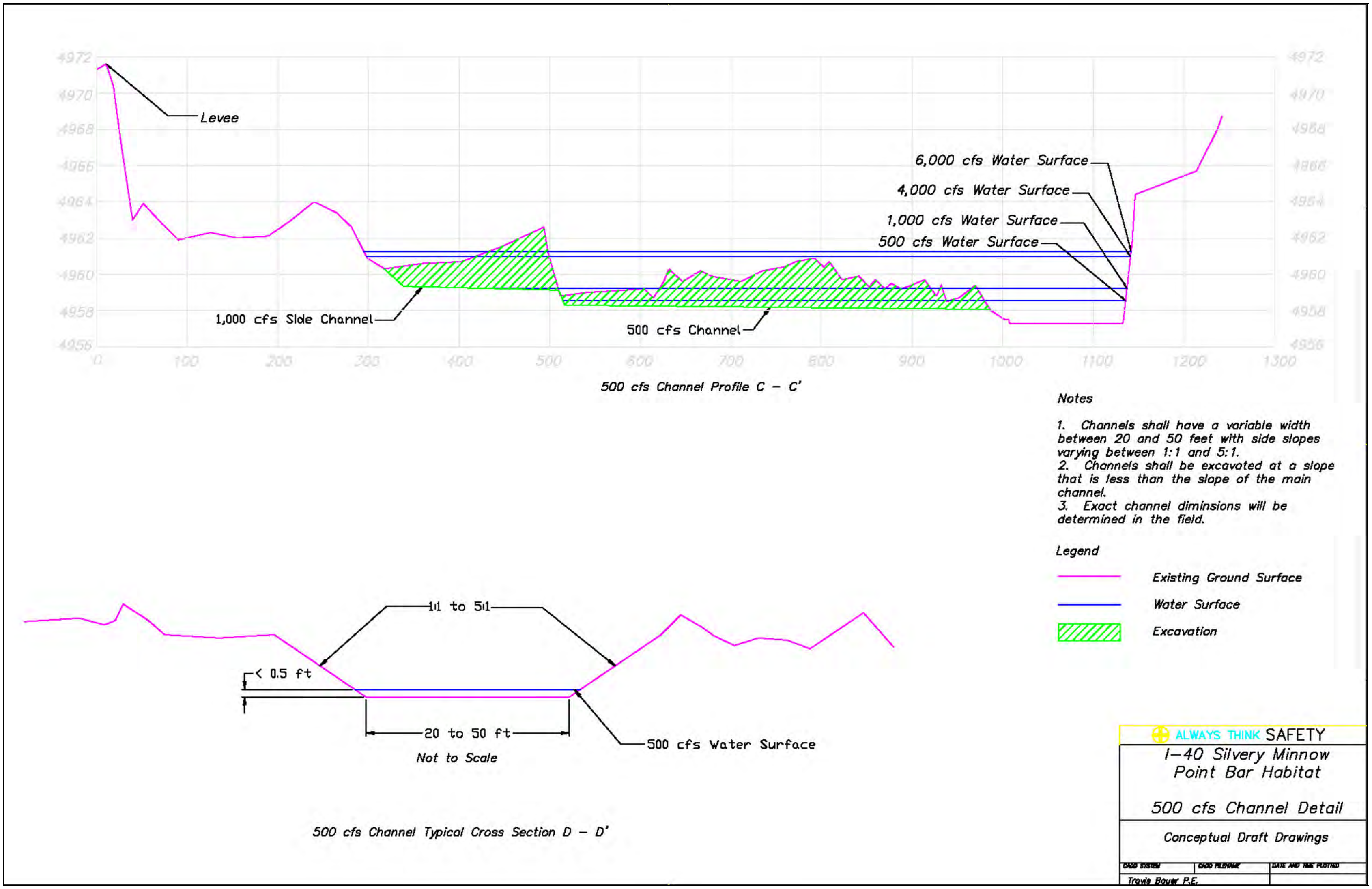

Figure 2.3. Schematic of the bar modification technique.

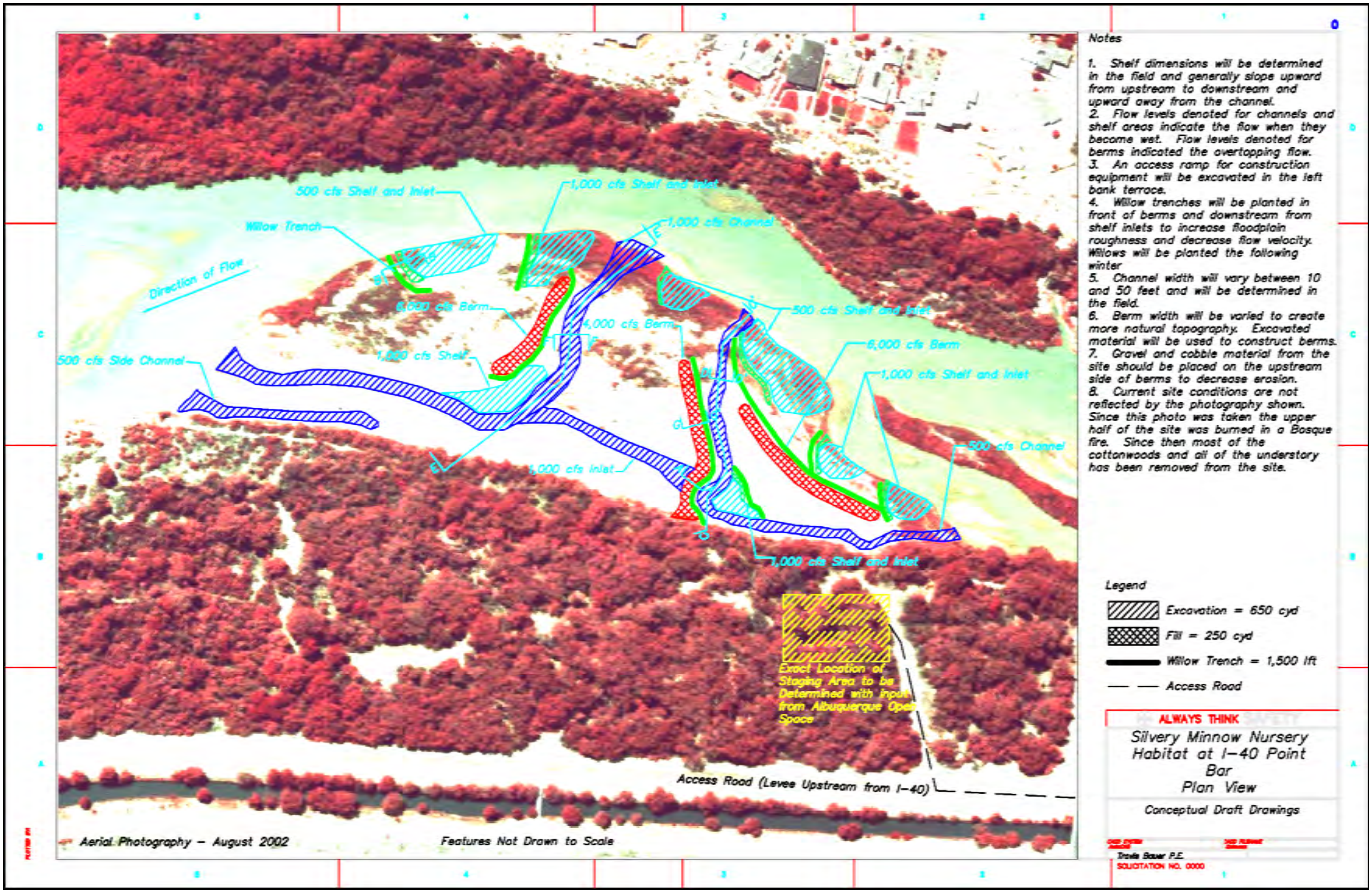

Figure 2.4. Example of the bar modification technique.

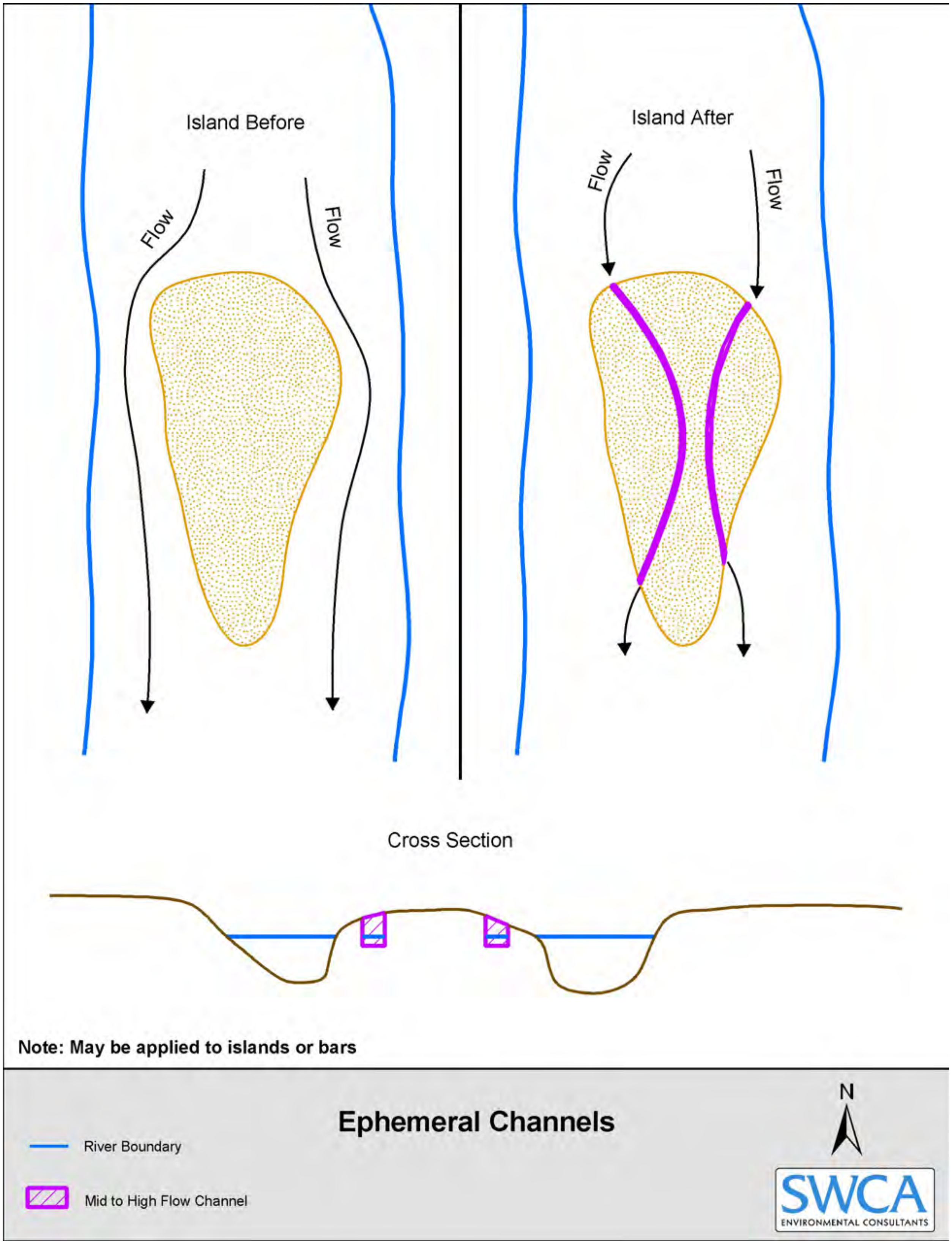

Figure 2.5. Schematic of the ephemeral channels technique**.**

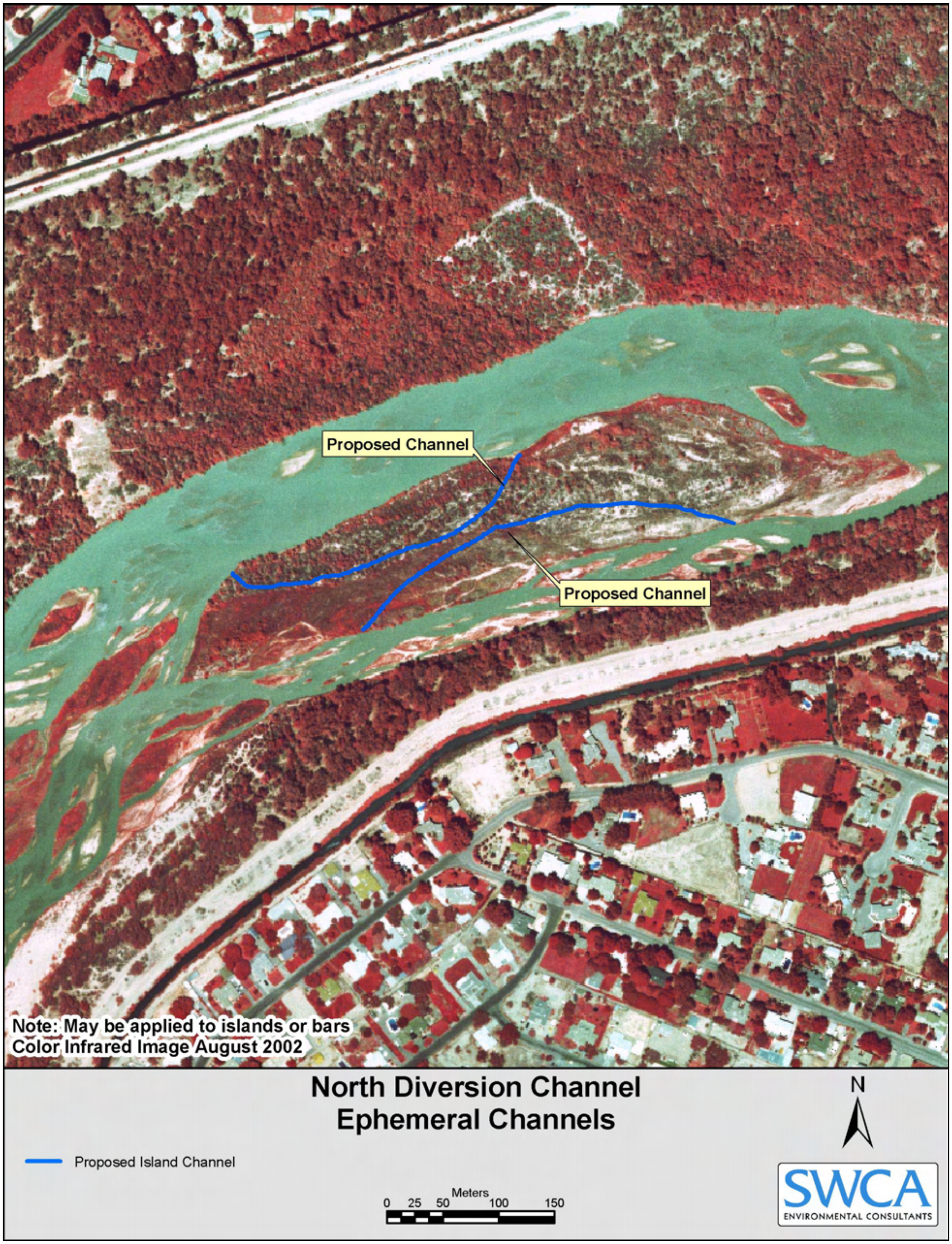

Figure 2.6. Example of the ephemeral channel technique.

Construction of an ephemeral channel requires removal of existing vegetation, most likely along the edges of vegetated islands that are not connected with the bank, and the disturbance of some sediment or soil. The channels would be cut through islands to a depth that would allow water to flow at moderate to high river flows (Figures 2.5 and 2.6). Channels may also be cut through sediment bars that are now connected to the banks. The design of the ephemeral channels would consider the river flow at which water enters the channel, water retention times, and velocity relationships. The ephemeral channels would be able to accommodate flows to encourage RGSM recruitment each year, especially using integrative passive techniques.

Ephemeral channels could provide sufficient periods of inundation for larval development and young silvery minnows. These side channels would dry during lower flows and would not be designed to provide habitat for adult RGSM. While channels of this kind are proposed primarily to enhance RGSM habitat, they also promote riparian functionality and interconnectedness.

2.5.2 BANK MODIFICATION TECHNIQUES

In the MRG, and especially in the Albuquerque Reach, the historic floodplain is disconnected from the channel and, given the current channel conditions, seldom experiences overbank flooding. The riverbanks tend to be composed of sandy-silt sediments that form vertical surfaces outlining the active Rio Grande channel. As a consequence, the bank line boundaries can be easily modified to include the construction of RGSM habitat. These techniques include, but are not limited to, placement of large woody debris, inlet scours and scallops, bank lowering, and altering attached bars or shelves. The bank modification techniques described below would be evaluated on selected large islands and may be implemented on the shoreline of the river or the bank line over the duration of the project. These techniques would only be applied in areas where such action would not increase flood risk.

Technique 4: Large Woody Debris

The large woody debris (LWD) technique involves the placement of root wads, trees, and branches in the main channel or near the bank to create aquatic habitats. LWD may be placed in the channel or anchored to the river bottom or bank. Anchored LWD tends to remain in place until decomposition sets in. LWD may be placed in high densities or dispersed throughout subreaches. Introducing LWD would promote increased habitat diversity and food availability.

Although LWD has been identified as suitable habitat for RGSM (USFWS 2003), no studies have been completed on the MRG to document the effects of significant increases in the amount of this habitat type. Prior to the 1930s, conditions in the MRG provided diverse quantities of LWD to the channel, as stream banks eroded and the river routinely migrated laterally across the floodplain, removing and transporting significant quantities of LWD from the riparian zone. While modification of the river channel and construction of dams for flood control and water delivery purposes are largely responsible for stabilizing the river and floodplain, creating the monotypic cottonwood gallery in the middle valley and significantly reducing flood threat, channel incision has essentially eliminated overbank flow in the Albuquerque Reach, reducing the amount of LWD in the river channel. For this technique, LWD would be placed in selected locations (Figures 2.7–2.9). The objective of this technique is to increase the amount of large woody debris present in the described subreaches of the MRG to enhance food availability and the mesohabitats utilized by RGSM.

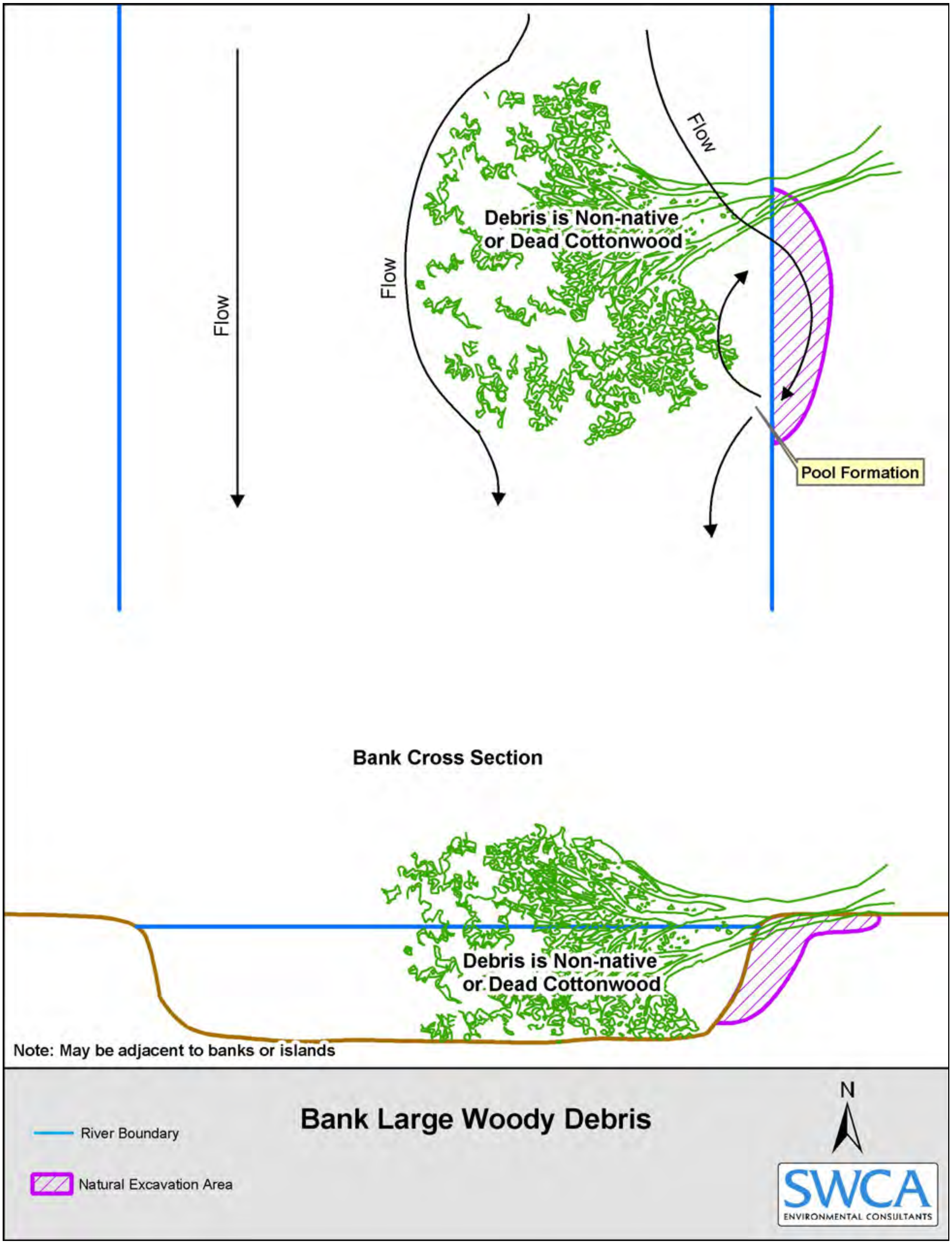

Figure 2.7. Schematic of the large woody debris technique used along bank line.

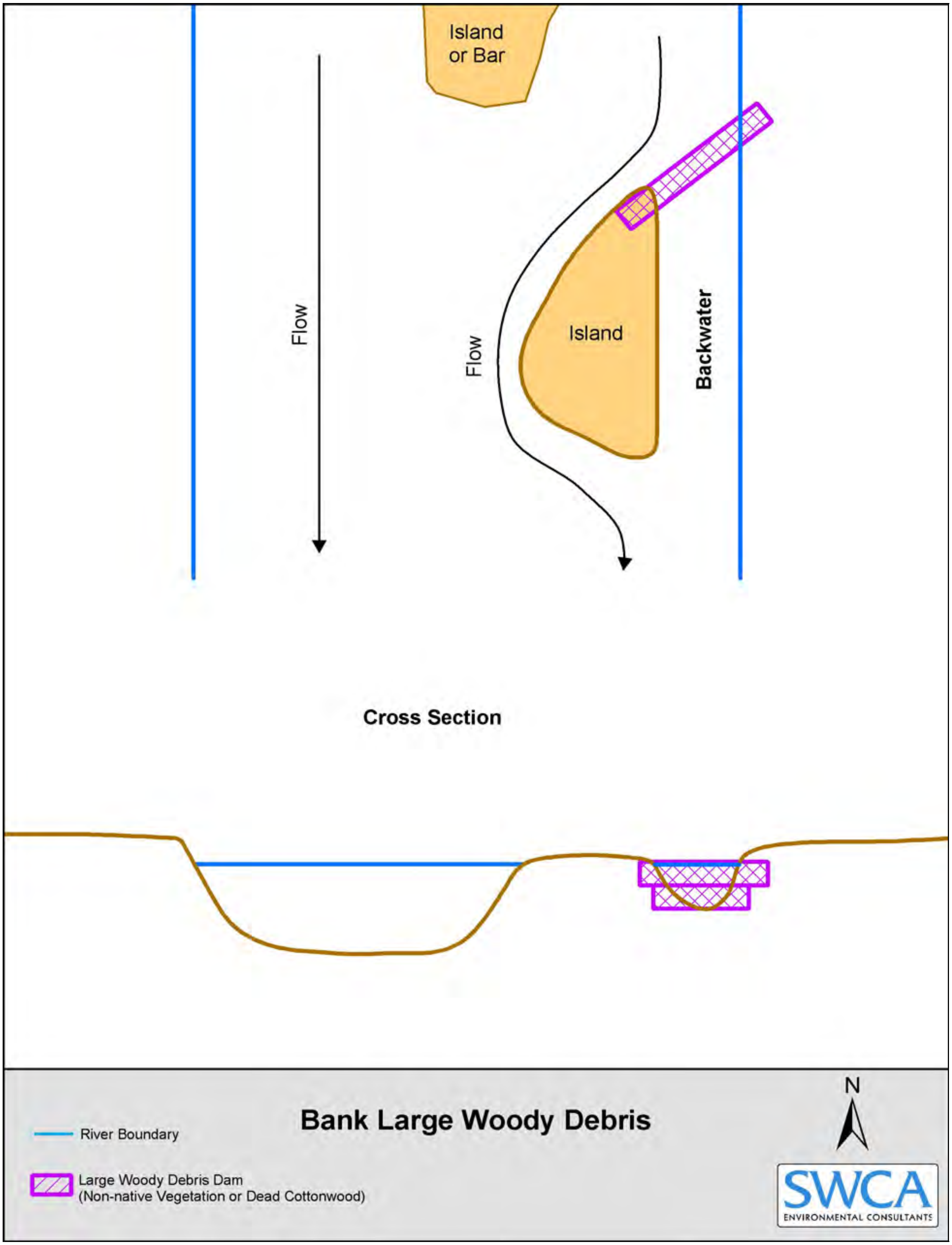

Figure 2.8. Schematic of using large woody debris as a debris dam.

Figure 2.9. Example of the large woody debris technique.

Technique 5: Artificial Bank Scours
Bank-line scours and scallops are areas cut into banks or islands where flow from the river channel enters, predominantly during high-flow events. Using this technique, scours would be created at areas where the thalweg comes into contact with the bank (Figures 2.10 and 2.11).

Scours are different from ephemeral channels in that they exchange water with the main channel within a small area instead of along a linear bank line. Scours may also be called inlets or embayments, although the function of embayments, which typically are constructed to create habitat for the RGSM, is slightly different. The purpose of scours or scallops is to create lateral migration of the river and to restore natural meandering of the system (William Lettis & Associates 2003; Tetra Tech 2004). Created scours would also provide low-velocity habitat for RGSM larvae and drifting eggs, rearing habitat, and increased food availability (Porter and Massong 2003).

Bank-line scours would allow the river to erode banks on one bank and deposit material along the adjacent bank, inducing lateral migration of the river. Lateral migration is essential to the functionality of the river and contributes to the overall health not only of the RGSM but also of all species that use the Rio Grande riparian and floodplain areas. The artificial bank scour technique would be evaluated initially on selected islands and may be implemented on the shoreline of the river or the bank line over the duration of the project. This technique would only be applied in areas where such action would not increase flood risk.

Technique 6: Artificial Bank Lowering
Bank lowering involves the removal of bank-line vegetation and excavation of soils to enhance the potential for lateral movement of the river and overbank flooding (Figures 2.12 and 2.13). The target elevation for excavated banks and islands varies, depending on the height of the bank and the bank full level. Bank lowering is needed in areas where the channel has incised or where overbank flooding is limited by the absence of sustained high flows. Areas where banks are lowered are anticipated to be inundated during periods of above-average discharge (not annual events). By lowering the bank, the frequency of inundation will be increased. The overbank areas would not remain flooded for significant periods of time and are not intended to provide mesohabitat for adult RGSM, but to provide the necessary conditions for other processes that would result in habitat improvements.

This technique is being evaluated to determine if it results in lateral migration of the channel within confined lateral extents. The artificial bank lowering technique would be evaluated on selected large islands and may be implemented on the shoreline of the river or the bank line over the duration of the project. This technique would only be applied in areas where such action would not increase flood risk. Such lateral migration would remove dense bank-line vegetation on islands or shorelines and increase deposition of fresh sediment. Lateral migration and overbank flooding would allow the river to create ephemeral nursery habitat for retention of RGSM larvae and eggs.

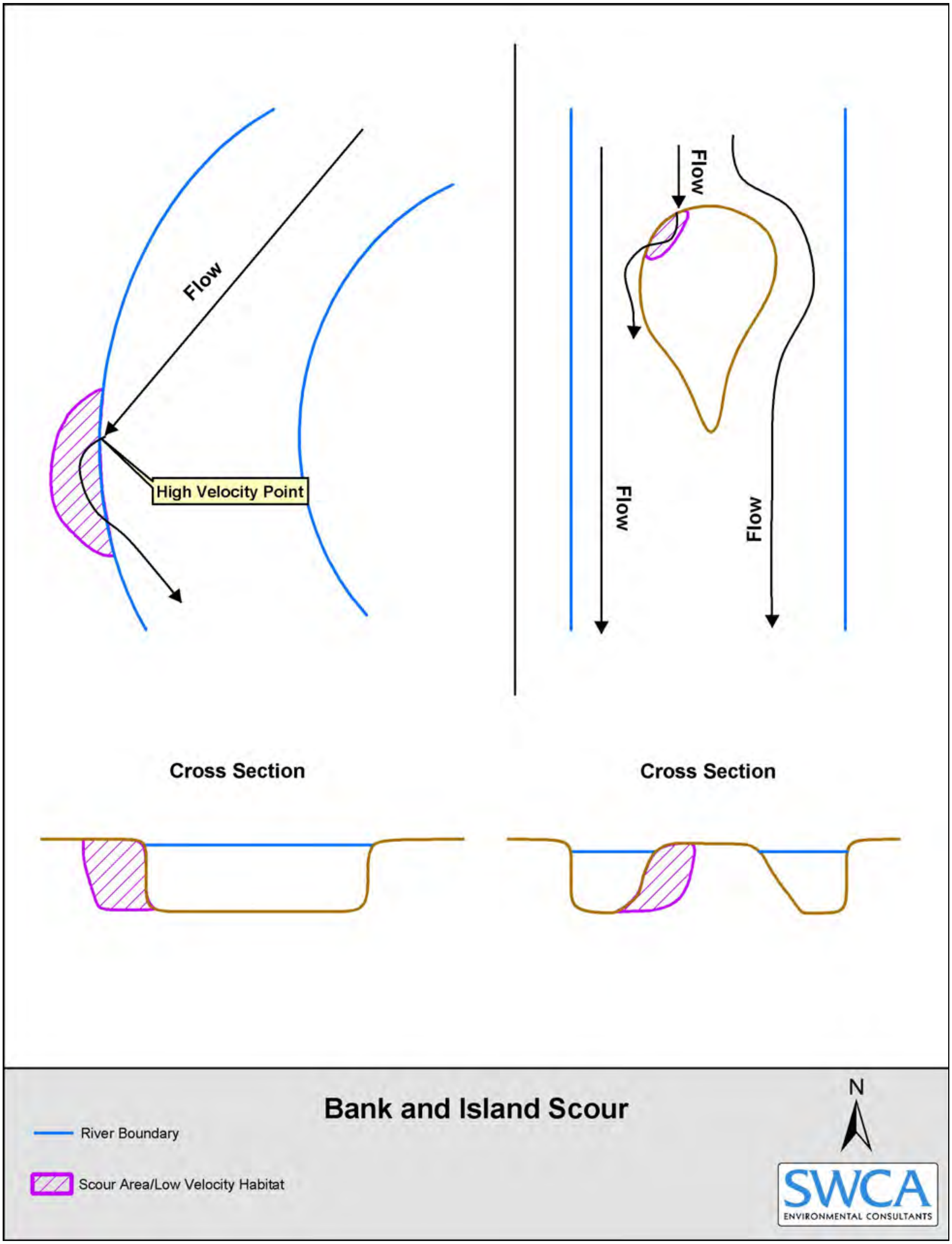

Figure 2.10. Schematic of the bank and island scour technique.

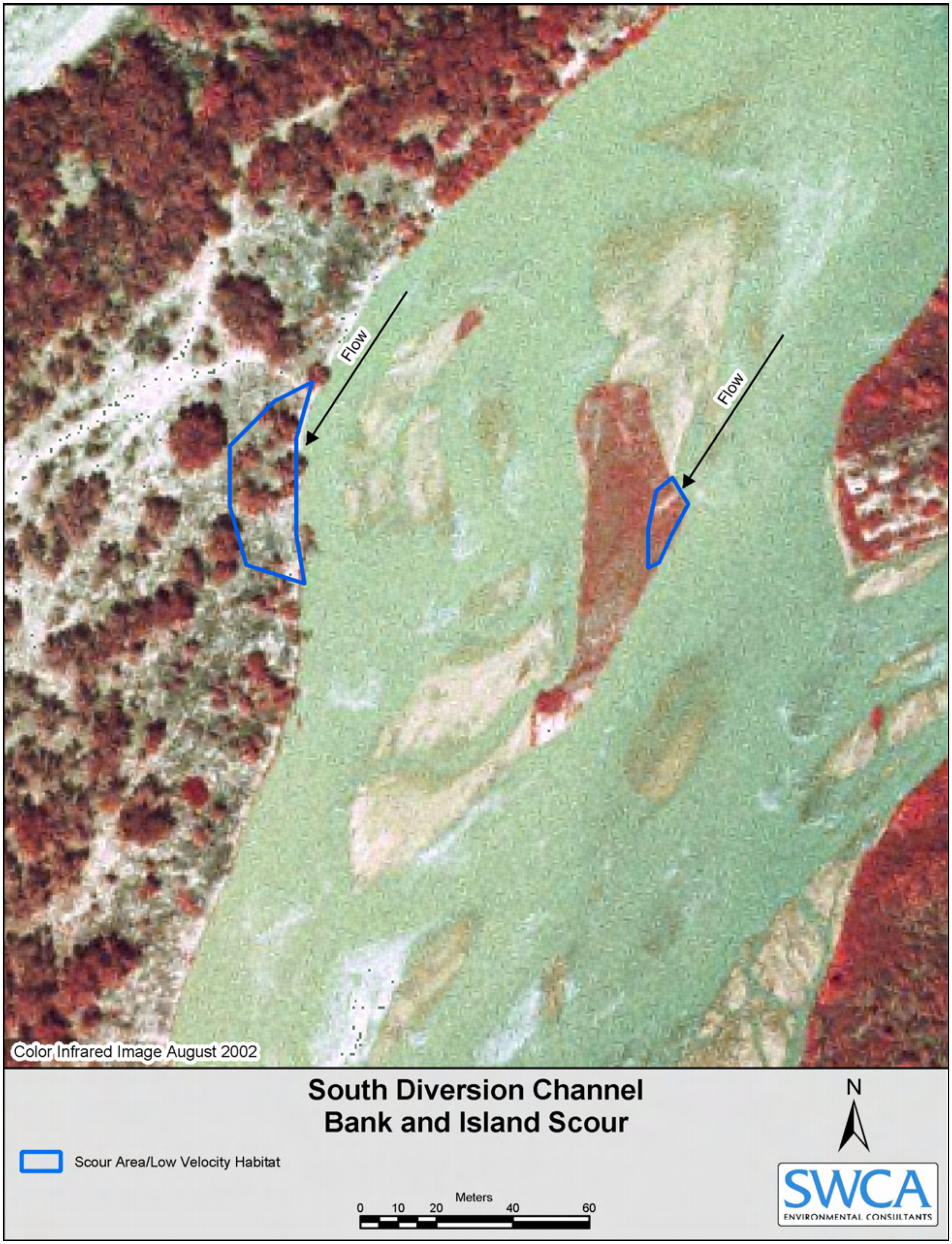

Figure 2.11. Example of the bank and island scour technique.

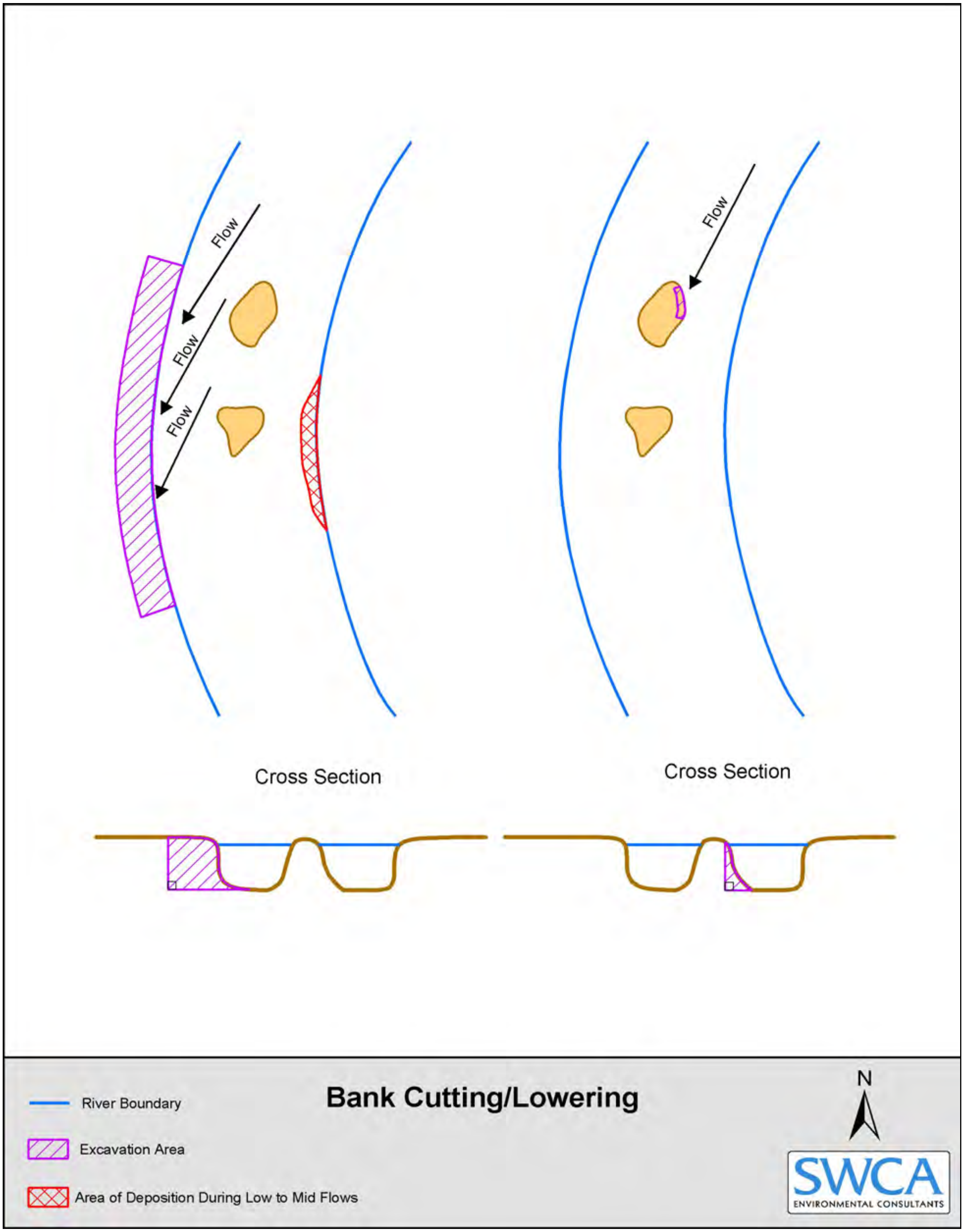

Figure 2.12. Schematic of the bank cutting/lowering technique.

Figure 2.13. Example of the bank cutting/lowering technique.